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Topics

LEAD HAZARDS

OCCUPATIONAL MEDICINE

SOLVENT ANALYSIS

and

I.L.O. MEETING

Occupational Health Division

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TABLE OF CONTENTS

Page

SURVEY OF LEAD HAZARDS IN THE NEW BRUNSWICK PRINTING INDUSTRY 1

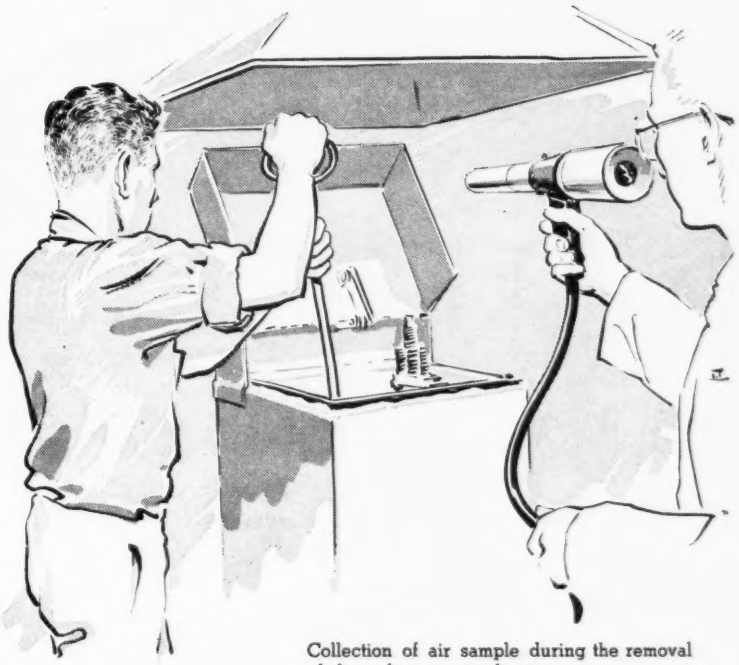
THE ROAD TO ABUNDANT HEALTH 5

SOLVENT ANALYSIS BY VAPOUR FRACTOMETRY 10

CHEMICAL INDUSTRIES COMMITTEE 12

Survey of Lead Hazards in the New Brunswick Printing Industry

C. R. Ross H. P. Sanderson J. L. Monkman



Collection of air sample during the removal of dross from a remelt pot.

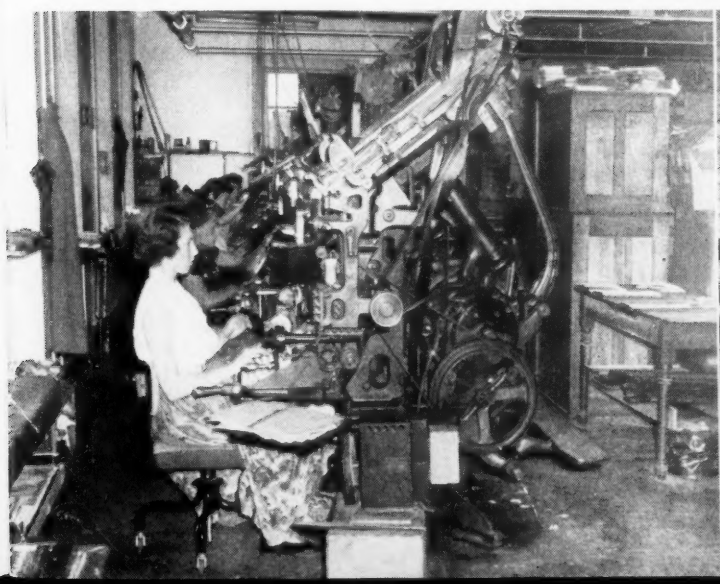
INTRODUCTION

Lead hazards in the New Brunswick printing industry were studied during the latter part of 1957 by the Occupational Health Division at the request of the New Brunswick Department of Labour. Eight printing plants, representative of the industry in the province, were examined. The survey consisted of the collection and analysis of air samples for lead; the critical examination of workrooms, processes and procedures; and the evaluation of exhaust hoods and ventilation systems. Sixty-six air samples were collected by electrostatic precipitation, and the lead content was subsequently determined by a dithizone method of analysis. Exhaust hoods were examined with smoke tubes and airflows were measured with a velometer.

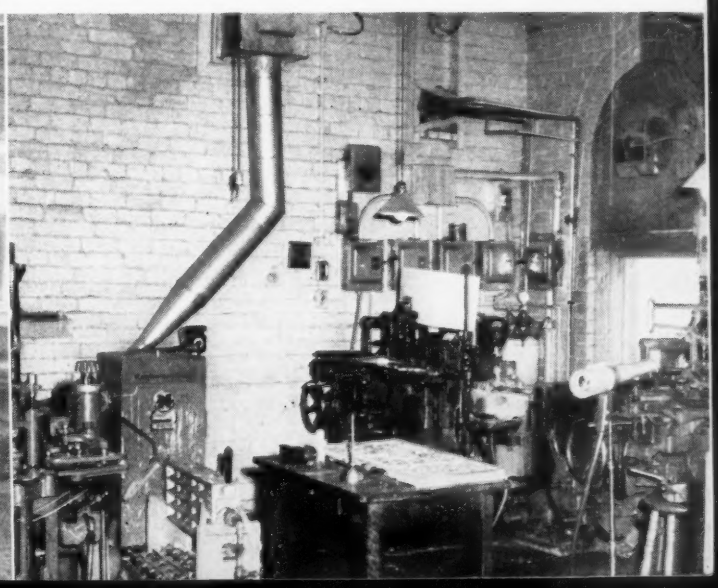
EXPOSURE TO LEAD

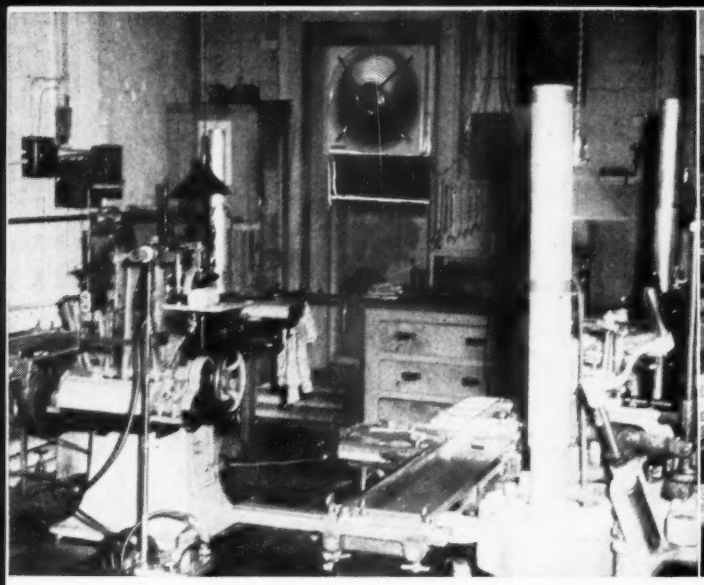
Exposure to lead in printing plants occurs during the operation of linotype, monotype or other typecasting machines; at composing benches where the type is assembled into page format; during the casting and trimming of plates for the printing presses; and during the re-melting of used type.

Linotype operation. The lead concentration measured here was 0.10 milligrams per 10 cubic metres.



A Monotype casting room. Electrostatic air sampler in foreground.





Gas-fired monotype casting machines. Note open window below general exhaust fan permitting the short-circuiting of the fan.

The composing operation. The lead concentration measured here was 0.11 milligrams per 10 cubic metres.

Most of the air contamination is the result of the dissemination of dross (fine lead oxide dust) which is produced on the surface of the metal primarily when it is in molten form. Removal of this oxide scum or any disturbance of the molten lead causes the dispersal of lead dust. Once the dust is airborne from this primary source it may settle and be redispersed many times and become an important secondary source. Volatilization of lead from lead pots is not an important factor unless the pots are over-heated. The temperature is usually thermostatically controlled.

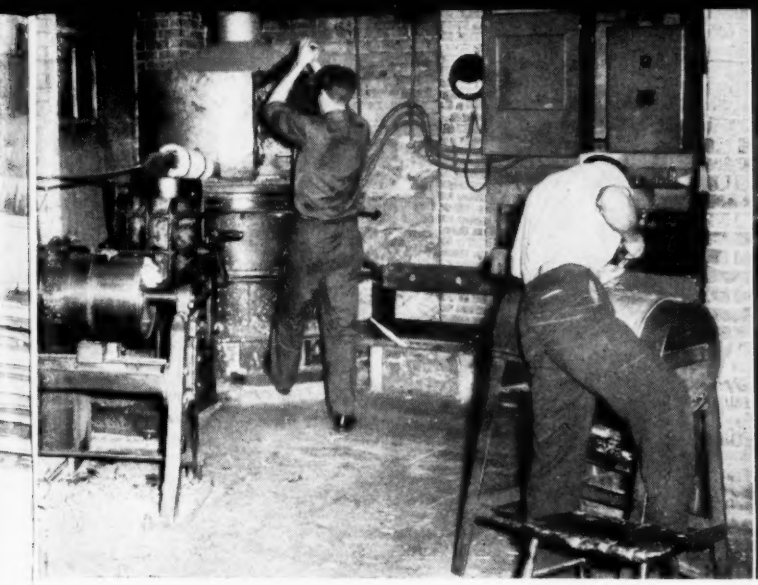
The largest quantities of alloy are melted and handled during the casting of plates for the presses and during the remelting of used type. These operations are recognized as the most hazardous in printing plants and are usually physically separated from the other printing processes and the lead pots are, in most cases, provided with exhaust ventilation.

Results of the lead determinations have been classified by operations and average concentrations found at the different operations are tabulated together with the range of the measurements. Average concentrations reported in the literature at the same operations are also included in the table and it will be noted that these concentrations do not differ substantially from the findings of the present survey.

RESULTS OF THE NEW BRUNSWICK SURVEY

With only two exceptions, the concentrations of lead found in the air did not exceed the threshold limit value of the American Conference of Governmental Hygiene Chemists of 2.0 milligrams per 10 cubic metres. The threshold limit value is the maximum concentration to which an average worker may be exposed for continuous 8-hour daily exposures. One of the two high concentrations was recorded during a drossing operation, the other when a cooling fan disturbed settled dust accumulations on the top of a fume hood. At most operations the concentrations measured were well below the threshold limit and it was concluded that the lead hazard in these plants was a minor one and could be readily controlled provided reasonable precautions were observed.

A totally enclosed routing machine used for newspaper plates.



Casting and trimming of plates for a newspaper press in a small plant. The lead concentration measured here was 0.63 milligrams per 10 cubic metres.

Smoke tubes shows poor collection of fume at natural draft hood over large lead pot.

Air Concentrations of Lead Observed in New Brunswick Survey compared With Those Reported in the Literature

New Brunswick Survey

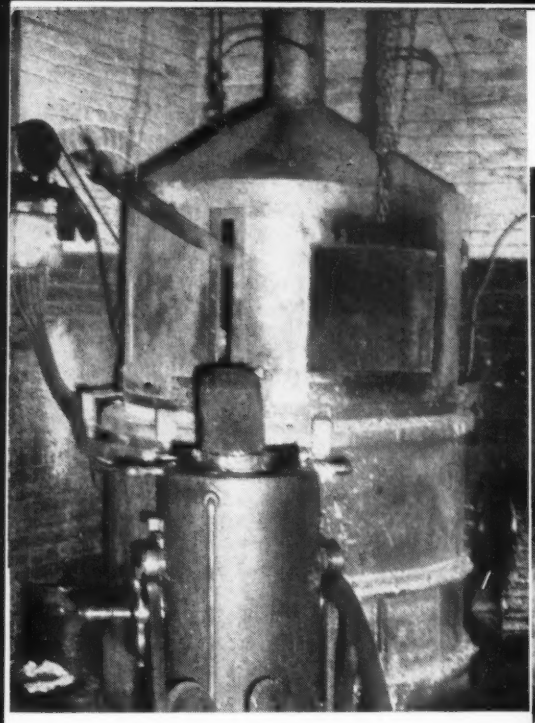
Description of Sample	No. of Samples	Range	Average	Keppler-Bumstead	Ruf-Belknap	Brandt-Reichenback	Homewood-Worshan
Operator Exposure	*Milligrams of lead per 10 cubic metres*						
Linotype	11	0.08 – 0.50	0.18	0.35	0.21	0.12	0.35
Remelt heating, loading	1		0.02		1.15		
Remelt pouring	3	0.25 – 1.40	0.77		0.53		1.37
Remelt drossing	1		24.2		35.5	1.96	122.1
Composing	11	0.04 – 0.29	0.14	0.19		0.62	0.37
Monotype and strip type casting machines	11	0.05 – 0.18	0.12				
Monotype drossing	2	0.30 – 0.89	0.60				
Stereotype	16	0.02 – 2.28	0.45	0.89		0.08	0.75
Saws & routers	2	0.18 – 0.42	0.30	9.04		1.22	
Fumes from Lead Pots							
Linotype	2	0.24 – 0.73	0.49	0.23	0.23	0.14	
Remelt	1		0.60				
Stereotype	4	0.07 – 1.88	1.27				
Monotype	1		0.30				

CONTROL OF LEAD HAZARDS

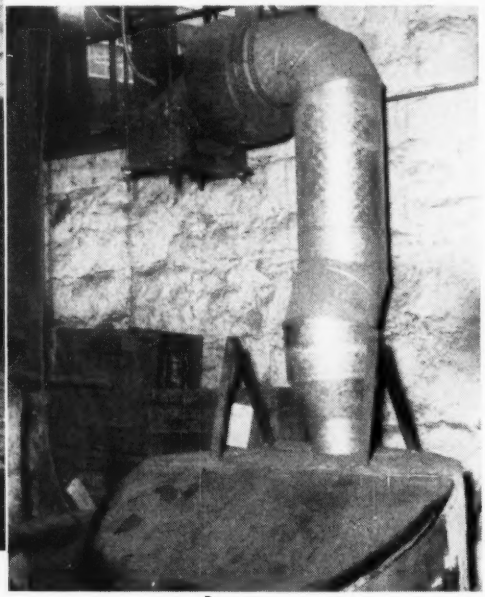
Important factors in the control of lead hazards in printing plants are the prevention of the dissemination of dross from the surface of lead pots and the prevention of the redissemination of any dross which may have escaped to the workroom. The primary dispersion may be largely prevented by carefully designed fume hoods over major lead pots. Prevention of secondary dispersion is primarily a question of good housekeeping.

Dangerous concentrations of lead are certain to occur during drossing operations unless great care is taken or special exhaust ventilation is installed. The dross is usually skimmed from the pot with a perforated ladle and transferred to a metal container. At the larger lead pots, cans of dross are usually found alongside the pot, sometimes overflowing. When the cans are filled they are capped and returned to the metal supplier for recovery of the lead.

One plant reported that the dross was sieved before returning it to the factory. Although this operation was carried on out-of-doors, it was felt that it could result in a dangerous exposure to lead and it was recommended



Operation of the cooling fan over this lead pot caused a sharp increase in lead concentration apparently due to the dissemination of settled dust from the roof of the hood. The door of this hood is hinged inward at the top which is a good feature as it is opened only momentarily during loading.



Remelt lead pot. The exhaust fan shown here discharged to the stack of an oil furnace and at times caused a reverse flow in the stack, with consequent contamination of the workroom.

A hood type which prevents escape of dross when lead pots are skimmed.

that the practice be discontinued. Other practices were observed which resulted in unnecessary dispersal of dross. For example, at one plant, the glue-pot used on a newspaper press was heated in the remelt pot. Each time this was done the container picked up a layer of dross which was carried across the room and dispersed into the atmosphere or spilled on the floor.

In most of the workrooms examined, the employees ate their lunches at their workplaces. While lead is much less toxic by ingestion than by inhalation, it was recommended that the eating of lunches in workrooms where lead is handled should be discouraged and not permitted in plate-casting or remelt rooms.

Housekeeping in most of the plants was satisfactory. In a few cases there were accumulations of dross or saw filings around machines. These accumulations are unnecessary sources of air contamination which may be readily eliminated. In some of the plants floors were cleaned by sweeping, in others the clean-up was carried out by vacuum cleaning. Vacuum cleaning is preferred in order to prevent the re-dispersion of any lead dust which might be on the floors.

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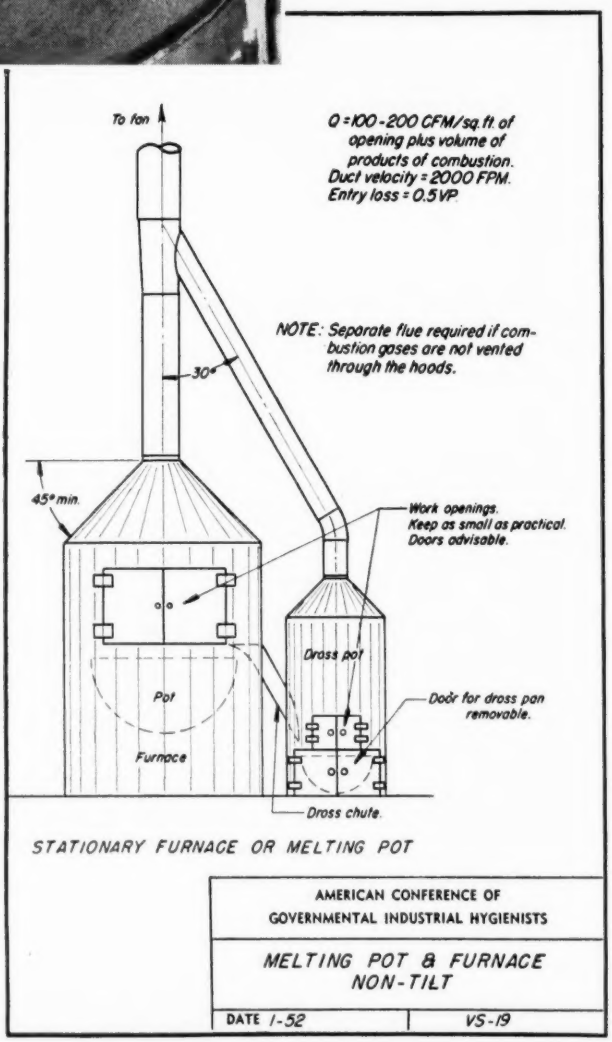
To fan
Q = 100 - 200 CFM/sq. ft. of opening plus volume of products of combustion.
Duct velocity = 2000 FPM.
Entry loss = 0.5 VP
NOTE: Separate flue required if combustion gases are not vented through the hoods.
30°
45° min.
Work openings. Keep as small as practical. Doors advisable.
Dross pot
Pot
Furnace
Door for dross pan removable.
Dross chute.
STATIONARY FURNACE OR MELTING POT
AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS
MELTING POT & FURNACE NON-TILT
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The Road to Abundant Health

by

Robert Collier Page, M.D., F.A.C.P.
(Author of "It Pays to Be Healthy")

OCCUPATIONAL medicine is that brand of medical service that the employed person needs and deserves in order for him to fully enjoy and appreciate the high standard of living he has justly earned. To this end he is entitled to a health program that will:

1. Prevent all preventable health problems.
2. Detect incipient health problems at a time when they can be corrected at a reasonable cost.
3. Keep him vertical and productive for the maximum period.
4. Treat him and rehabilitate him in the event of unforeseeable major medical catastrophes under a sound indemnity plan.
5. Educate him in the construction as well as maintenance of health.

With an eye to his budget, plus a certain amount of luck, the worker of today can live better than his counterpart of any other conceivable area in the world or era in time. Costs of living have climbed to unprecedented levels, but wages, productivity and purchasing power have kept pace, thanks in part to modern technological progress and in part to the efforts of organized labor.

But there is a "crack in the picture window!"

If wages have more or less kept pace with the rise of normal living, costs of after-the-fact hospital or medical care have not, nor is it economically likely that they will ever do so. When the average worker runs out of luck, or when he or someone in his family is put *entirely* out of action by a major medical catastrophe or *partially* so by a creeping chronic illness, he is in a worse position than his grandfather would have been. He is even in more profound trouble than his more poorly-paid counterpart in some underdeveloped part of the world. All of his years of frugality, of budget-cautious accumulation of the accoutrements of the more abundant life, are cancelled out in a blow.

Thoughtful leaders of organized labor have recognized this appalling fact for many years, and have pursued or discussed a variety of possible solutions. Until recent years there have been two principal types of solutions sought through collective bargaining, political action or co-operative effort. These have been:

1. Complete after-the-fact medical and hospital care to be furnished free or at a nominal cost by:
   a. The employer
   b. Government
   c. The union
2. Insurance plans partially subsidized out of company profits, taxes or union welfare funds to indemnify the costs of medical treatment and/or hospitalization.

A study of these solutions will show that not only have they failed to increase the quality or lower the costs of medical care, but in the long run they have done exactly the opposite and must inevitably continue to do so. The modern hospital today is perpetually overcrowded and understaffed. Any plan which makes it financially easy for an individual to avail himself of hospital bed space, whether he needs it badly or not, can only compound this condition. Costs of hospital care must rise accordingly, and no matter who is footing the bill immediately, the cost must eventually come back to the user of medical services, in increased premium rates, taxes, union dues and prices of goods and services. Doctors besieged by subsidized patients with multifarious minor health problems must, of

necessity, become "assembly-line doctors," and let quality service go by the board. This has been seen in England under National Health Insurance; it has been seen in tropical areas where foreign corporations have, for the sake of mere expediency, got themselves into the business of medicine—offering free care, treatment and hospitalization to all workers and their families. The quality of medical care is in inverse ratio to the demand for it; the cost is approximately geometric in ratio to the demand and is passed on to the consumer.

The two types of solutions mentioned above have been pursued as a result of faulty or incomplete advice. Labor leaders are coming to realize this, and are beginning to move over to the right track by seeking medical care with strong *quality* controls, instead of mere indemnification or mass-produced medical service[1].

The danger in this is that, even with the most rigid quality controls, medical care can turn into an overpriced commodity, or go the other way and relax its standards of *quality*, thereby becoming a *quantity* proposition, *unless "quality medical care" is properly defined at the outset and established according to a constructive philosophy.*

What the employed person wants and needs to maintain the high standard of living he has earned is the kind of medical service outlined in my first paragraph. This and this alone will solve the twin problems of quality and cost.

All of which means that medical progress is of vital interest to the employed person, the physician and the community. The machine age of today is helping, rather than hindering, mankind in its search for health. Heretofore, the conflict of man and machine has been such that accident, illness and sudden death have been accepted as necessary for progress. Now, thanks to the present interest in the field of human relations in industry, leading universities are conducting research programs, supported by both labor and business, to improve the health of the worker. Top executives and experts in scientific management and medical, public and employee relations are holding frequent meetings on various phases of the subject.

The industrial health of the employed population is important if maximum utilization of the human resources of the country is to be maintained for efficient production and full employment.

Progressive management no longer confines its activities to the engineering sciences, fundamentals of sanitation and public health, lighting, temperature, ventilation and physical safety when considering industrial health. More and more interest, time and money are given to the social sciences, in which the physician's knowledge, experience and appreciation are outstanding. Nevertheless, to date, the physician has failed to impress the public at large with his unique capabilities in the field of social science.

All physicians are conscious of much unsound medical legislation. Today, with the general public becoming more alert to personal health needs, there is a *similar* public fear of future unsound demand for medical legislation. To offset this possibility, the ideals of the profession must be correctly and earnestly promulgated.

With the appreciation of this fact it behooves the various members of our profession—the internist, the surgeon, the ophthalmologist, the neuro-psychiatrist, the medical consultant to industry, and the general practitioner—to understand the meaning of teamwork and human relations. The whole fabric of any community—all the political, social and economic bonds holding its various segments together—depends on the provision of having jobs and opportunities to make a living. Human relations on the job are much more complicated than other aspects of living. At other times and places a person is left largely to his own devices, but at work he has to adjust himself not only to the job itself and its physical environment, but also to his supervisors, other people around him and the rules and regulations of the organization.

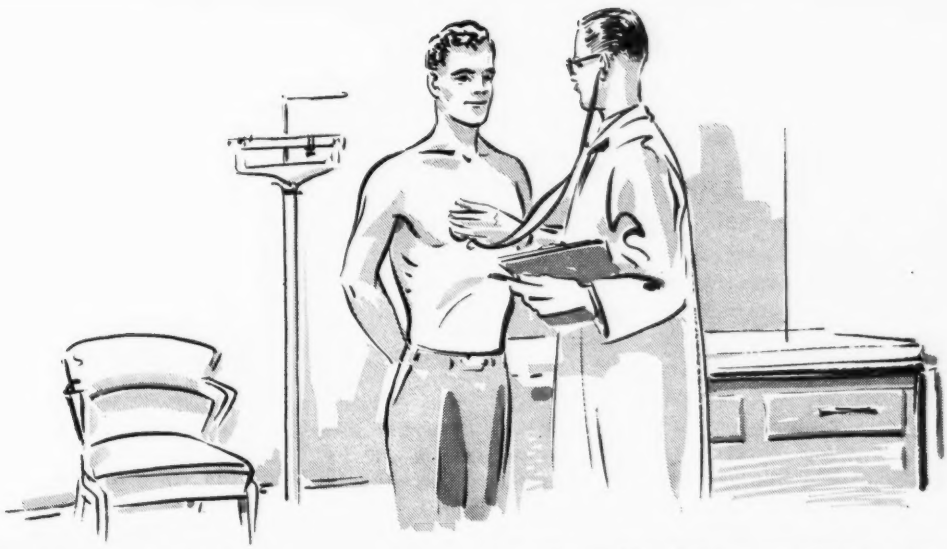
There is abundant evidence that many workers are not adjusting themselves properly. Many such people are not well. Naturally, the question arises regarding the best method of determining the exact nature of their illnesses. It cannot be assumed that a person is perfectly well when he shows up for work in the morning; likewise, it cannot be taken for granted that he is ill when he stays away. Such thoughts bear directly on the question of absenteeism.

Unfortunately, perhaps, the average practicing physician confines his interest to the immediate problem of the patient. He readily detects physical defects, but time alone prevents him from evaluating the patient's entire personality, the combination of his traits, reactions to other persons and to strain and stress, and his particular emotional makeup and pattern—in other words, his entire physical, mental and social state.

It is my conviction that medicine as an independent scientific and cultural endeavor must in the future devote itself to this important constructive approach.

Progressive, foresighted managements that have acknowledged their role as policy makers with respect to matters of health have been able to appoint leaders in the medical profession as consultants to their staffs.

It is reasonable to assume that in the not-too-distant future, all problems of a medical nature having to do with the employed person will be interpreted in terms of how a particular condition affects or is affected by the employee's actual working environment. This is a far cry from considering personnel medical problems exclusively in the light of absentee records. It is a forward-looking, all inclusive policy that has its roots in the periodic health audit.



PERIODIC HEALTH INVENTORY

The periodic health audit of individual employees is obligatory for a modern, constructive health-maintenance program. The program actually begins with the placement examination, which goes beyond the usual so-called pre-employment examination. Far more details are sought here; the employee is considered in relation to his job, *the physical examination per se* taking its rightful place in the medical analysis of the total person.

The next step is the performance of a comprehensive periodic inventory at suitable intervals determined by the private practicing physician. Such an inventory will include the sociologic history of the employee, all emotional factors, his reaction to stress and strain, and the character of his home life and outside activities—all of which, when coupled with the actual physical finds, give the examining physician the facts necessary to consider the employee from the point of view of total environment. This is the 1958 way of saying what the general practitioner of the 1920's knew when he "saw all, heard everything" but said nothing to his patient.

Once a constructive health-maintenance program has been started and periodic health inventories of all employees have been made, the environmental approach can be carried one step farther. All employees, from a strictly medical point of view, may be placed in one of the following eight classifications: normal health; situational state (no existing disease); functional disorder; neuropsychiatric state; cardiovascular disease; neoplastic disease, metabolic disorders; and all other medical problems. A few of these are considered at length.

NORMAL HEALTH

The properly managed, constructive health-maintenance program assumes that, if the patient in industry is still capable of doing an efficient job, he is normal until proved otherwise.

This state may well exist even in the presence of such abnormalities as heart disease, arthritis, kidney or liver disease, hypertension or arteriosclerosis. All these are, in a high percentage of cases, physiologic changes that can be ancitipated as normal age progresses. In other words, these diseases may be considered the inevitable rewards to which man falls heir as he follows the natural course of aging. The important point is for the man to learn his limitations and how to live a full life within them.

A wise man once put it in more picturesque fashion: "He who fills up every hour of his life with activities within his abilities to perform will insensibly glide into old age without perceiving its arrival, and his powers, instead of being suddenly and prematurely extinguished, will gradually decline by the gentle and natural effect of accumulating years." These words of Cicero appeared in an article entitled "On Old Age" written nearly 50 years before Christ. They are as true now as they were then.

It is immediately apparent that this approach to the patient—the assumption of normalcy—is diametrically opposed to what one was taught in medical school, and to the philosophy to which the student of yesterday and the average doctor of today were exposed throughout the professional training period. I was taught to consider each patient as having some type of disease until the contrary was proved. In other words, each patient, because he was a patient, and had come to the doctor, was abnormal.

No longer, as Dean Berry, of Harvard, has clearly pointed out, does one take this negative attitude. Without question, the new, positive approach is most practical when applied to industry. Eventually it may be applied in general to medicine, which will then be in a true "era of normalcy."

SITUATIONAL STATE

Before the situational state can be clearly understood, this must be defined. Both World War II and the Korean War offered evidence that every man has his emotional as well as physical "end point." For many reasons, among which could be listed improper job placement, unhappy home or working environment and lack of intelligent observation by a responsible supervisory staff, many persons in industry are approaching this end point. Once this point has been reached they will become the unemployables of industry. Therefore, this term is applied to the vague group of complaints affecting persons whose end point is being reached after varying periods of exposure to circumstances beyond their control and against which they are powerless to act.

The situational state, together with its more advanced form—the functional disorder—may be detected early, provided the local superintendent, foreman or superior is alert to the situation. It can be detected early for the simple reason that the employee's work efficiency begins to suffer as his end point is approached. Therefore, theoretically, most of these employees can be handled successfully by *other* than medical personnel with the proviso that they are trained in human welfare and understanding. It is an accepted fact that functional disorders, or so-called psychosomatic complaints, have their origins in nonmedical sites and, generally speaking, occur in persons eighteen to thirty-six years of age.

Patients with the more severe situational states and the functional disorders should, of course, be referred to the medical consultant to industry. He is the agent most capable of diagnosing and suggesting remedies—usually by changing the worker's environment.

An employee suffering from a severe situational state could very easily progress, if not under competent observation and treatment, to the status of a person with a real functional illness showing definite organic change. The most common example in industry—perhaps the elite of all the functional illnesses—is the duodenal ulcer. The ulcer has been called the "wound stripe of civilization." It would be better, perhaps, to call it the service badge of competition, for it is in the highly competitive industry of today that the natural progression from situational to functional disease, followed by ulcer formation, is most common.

NEUROPSYCHIATRIC STATE

The situational state, if unchecked in its early stages, can also progress normally to the fourth classification—that of the neuropsychiatric conditions. These patients often slide rapidly into full-blown neuroses, manifested by anxiety states, severe depressions with suicidal tendencies, or conditions of complete withdrawal bordering on the psychotic.

A common evil halfway between the situational state and actual neuropsychiatric disease is alcoholism. Too often, problem drinking has its roots in a combination of situational difficulties and emotional factors that, if detected early enough, would have prevented the development of the sodden, half-man who haunts the offices of personnel directors and physicians both within and outside industry. Although the concept of problem drinking as a disease and the consideration of the factors that lead a man to become an alcoholic are currently regarded as new, the following description was written by Charles Lamb, in his Confessions of a Drunkard, in 1822:

"Twelve years ago, I was possessed of a healthy frame of mind and body. I scarcely knew what it was to ail anything. Now, except when I am losing myself in a sea of drink, I am never free from those uneasy sensations in head and stomach which are so much worse to bear than any definite aches and pains.

OTHER CONDITIONS

In the remaining classifications—cardiovascular, neoplastic, metabolic and others—the medical consultant to industry is often the one to make the diagnosis. Once this has been done, he refers the patient to a clinician for definite therapy. He remains in the picture only as the member of the team who made the diagnosis. Of course, he continues to act as liaison man between the patient and his private physician on the one hand and the company on the other.

All disease—whether it is neuropsychiatric, cardiovascular, neoplastic, metabolic or other—is more easily cured if it is detected early. Early detection is the watchword of the medical consultant to industry. It is only by early detection, followed by correct *supervised* therapy that the employee will be returned to the classification into which all employees fall in an ideal industrial medical setup—namely, normal health and adjustment.

The policy makers, if guided by competent medical advice, are on solid ground as far as public opinion of its attitude toward its members or employees is concerned. The employee, in turn, profits by this managerial interest in his behalf. He feels better, has more energy and performs his duties in a manner that is beneficial to him and to his family as well as to his employer. Assignments as consultants to progressive companies are a challenge to the qualified physician. He is in a position to do so much for so many.

To maintain health "requires the ingenuity of many, the application of the accepted knowledge of the few, and the appreciation of its worth to employer and employee alike." Unfortunately, most policy makers still think of health in its negative sense—in terms of drugs and hospitals, pain and worry, sickness and death.

Yet they should be thinking of health in terms of mental and physical vigor and the ability of a worker to enjoy a useful and productive life with his fellow associates. Enlightened policy makers realize the importance of this positive approach to the question of health. They measure the health of an industrial worker with statistics on housing, nutrition, production and employment rather than with statistics on absenteeism, frequency of accidents, morbidity and mortality.

MANY TOOLS

The tools of occupational medicine are many. Knowledge of normal human physiology and the physiologic aspects of disease is only one basis for improving health, for there are others: better nutrition, guidance in selection of occupation, avoidance of prolonged and excessive fatigue, proper balance between work and play, selection of appropriate physical exercise and general habits compatible with physical and mental wellbeing.

Such a program requires a complete understanding of purpose among the patient (when he is well and when he is ill), the policy maker and his physician. Teamwork within the medical profession is the next prerequisite. The medical consultant to industry, the general practitioner and the specialist must consider the entire problem in terms of the patient if they are to justify the ideals of the profession.

The growing interest in the field of human relations affords the medical consultant to industry an opportunity to practice medicine in its broadest sense. He acts as a medical consultant to the worker, to the employer and to the private physician. He renders an unbiased and effective service to all.

The average employee is now getting better medical care than he ever got before. Because he is healthier he produces more. In turn, industry is able to provide more effective medical care in steadily increasing quality. Here, then, is a reward that both labor and management are enjoying together.

I subscribe to the theory that the health problems of competitive enterprise are not complex, assuming, of course, that the policy makers and the medical profession acknowledge the over-all problem and are willing to do something constructive about it. The present-day "curative" approach to the health needs of the nation, in terms of cost and often questionnable proficiency, is staggering both in scope and in effect. On the other hand, the positive route, with its potential value in the realm of good human relations, is still underdeveloped territory. A healthy, happy and suitably occupied person is a good citizen.

CONCLUSION

A fitting conclusion to these remarks is given by the following words of Lemuel Shattuck, written a hundred and four years ago:

The science of preserving health and preventing disease should be taught as one of the most important sciences. It would be useful to all, and particularly to the student of curative medicine.

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[1] "Union Boss Bows to Private Medicine"—Clifford F. Taylor—Medical Economics, Mar. 3, 1955. P. 102.

This article is from an address delivered by Dr. Page at the recent annual meeting of the Health League of Canada.

Solvent Analysis by Vapor Fractometry*

by
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Solvents, lacquer thinners, chlorinated hydrocarbons and similar organic liquids used in degreasing operations dry cleaning, paint and plastic manufacture are toxic materials and potentially hazardous to health and safety when their concentrations in air rise above certain limits. The Occupational Health Division has been frequently called upon to perform qualitative and quantitative analyses of these common solvents to determine what components—xylene, toluene, petroleum naphtha, ketones, esters, etc.—may be present, and in what concentrations.

Standard practice has been to use refractive index, boiling point, or molecular weight determinations. However, these classical measurements require highly pure substances if they are to be precise. Laboratory distillation techniques are time consuming and tedious. It often requires 24 hours for a still to reach equilibrium. Moreover, the column can easily flood or run dry and the resulting fractions may not be clean cut. It is not unusual for a multicomponent analysis by ordinary laboratory methods to take a week's time.

Identification of Ketones

Gas chromatographic techniques have provided a fast, reliable solution to this tough problem. The identification of ketones has been described below to illustrate one way in which the technique has been employed here.

The unknown solvent is first run on the Model 154-B Vapor Fractometer to establish whether the material in question consists of one or several components. Having from such a preliminary run, some idea of the number of major components present, it is now necessary to be able to identify the peaks obtained. The use of retention times as a means of classification is not sufficiently definite, and the use of some additional analytical criterion is advisable to make identification certain.

Ketones, present in the above-mentioned materials, are easily identified, as a class, by passing the effluent gas from the Vapor Fractometer into a solution of 2,4-dinitrophenyl hydrazine. The formation of a yellow crystalline precipitate indicates the presence of a ketone.

Procedure

The reagent is prepared by dissolving two grams of 2, 4-dinitrophenyl hydrazine in 15 ml. of concentrated sulphuric acid. This solution is added carefully with stirring to 150 ml. of 95% alcohol and the solution is then diluted to 500 ml. with distilled water. This freshly prepared reagent is allowed to stand in the refrigerator over night, and any precipitate formed is filtered out. This clear light yellow solution keeps well and may be stored in the refrigerator when not in use. One half to two milliliters of the reagent is placed in a 15 ml. conical centrifuge tube mounted on a retort stand. The shortest convenient length of clean rubber tubing is attached to the gas outlet of the Vapor Fractometer. To this is attached a six inch No. 20 stainless steel hypodermic needle. The needle is mounted vertically on the same stand with the needle tip immersed to the bottom of the centrifuge tube. During a run, the effluent gas mixture bubbles into the reagent from the needle tip continuously, ensuring intimate mixing.

With the Vapor Fractometer equilibrated for a run at a suitable temperature and gas flow rate, 5-20 microliters of the solvent mixture are injected into the column using an "Agla" micrometer syringe. The effluent for the complete run may be passed through the reagent, and as peaks occur on the recorder the appearance of the reagent is noted. When a peak due to a ketone appears, the clear light yellow reagent becomes turbid, and fine yellow crystals of the 2, 4-dinitrophenyl hydrazone appear, which, on continued bubbling, coagulate. When a positive test is obtained, it is, of course, necessary to change the reagent container for a fresh tube of reagent, since it is possible that another ketone might appear during the remainder of the run.

This test may be used in the visual manner indicated. It is positive for small amounts of ketones, and no reaction occurs with esters, alcohols, hydrocarbons and chlorinated hydrocarbons which may be present in the original sample mixture. By correlating retention times with a positive ketone reaction, identification of a given ketone may be made almost certain.

If it is desired to carry the identification further, the melting point of the crystalline derivative, or the ultraviolet spectral transmittance of a solution of the derivative may be determined. In the first case the crystals may be purified and a micro melting point determined on the Kofler hot stage microscope. In the second case, the crystalline derivative is extracted from the reaction mixture with spectroscopically pure iso-octane, and the ultra-violet curve of this solution is established on the Spectracord spectrophotometer.

*Taken from the Perlain-Elmer Instrument News for Science and Industry, Summer, 1957. Vol. 8, No. 4, Norwalk, Conn.

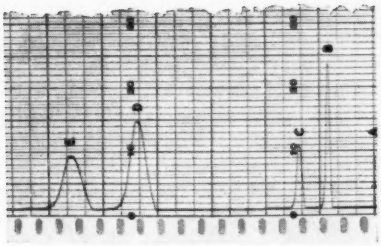

Figure 1. SIMPLE SOLVENT

5 microliters injected Agla syringe; Temp: 80°C.; Helium: 10 psig; Sensitivity: 4; Column: "A" 2 meters; Positive test for ketone at "C". (A) start (B) isopropyl alcohol 15% (c) methyl ethyl ketone 10% (D) toulene 40% (E) butyl acetate 35% proportion by volume.

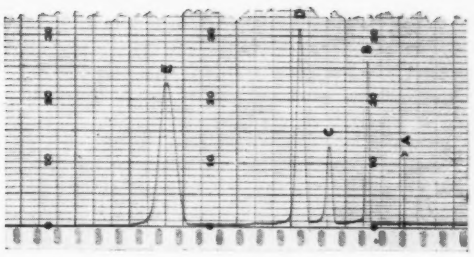

Figure 3. COMPLEX SOLVENT

10 microliters injected Agla Syringe; Temp: 80°C.; Helium: 10 psig; Sensitivity: 4; Column: "A" 2 meters; Positive test for ketone at "C".

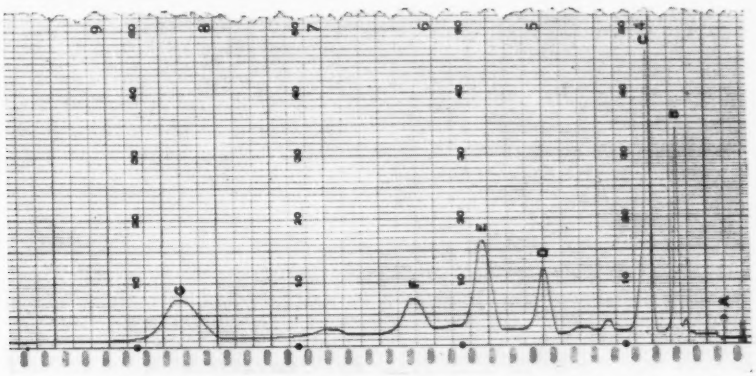

Figure 2. FAIRLY SIMPLE SOLVENT

5 microliters injected Agla Syringe; Temp: 80°C.; Helium 10 psig; Sensitivity: 4; Column: "A" 2 meters; Positive tests for ketone obtained at "B" and "C". (A) start (B) acetone 10% (C) methyl ethyl ketone 10% (D) benzene 30% (E) toulene 50%.

Conclusions

The reagent is not specific for ketones; aldehydes also react. However, aldehydes are not likely to occur in the type of material discussed. On the credit side, the reaction is immediate, i.e., the presence or absence of ketones is established while the run is in progress. The reaction is highly sensitive, 0.5 to 1.0 microliter of a ketone being easily detected.

Author's Note:

(After having analyzed this solvent by fractometry and by conventional methods, it was learned from the supplier that the material had been made up using six components as follows:

a. Sample injection point

b. Isopropyl alcohol 10% by volume

c. Methyl ethyl ketone 20%

d. unknown—possibly butyl acetate

e. Toluene 15%

f. Butyl acetate 10%

g. Xylene—mixture of meta and para 15%.

The naphtha peak being too high boiling for the selected operating temperature does not appear on the recording. It was known that at least one component was missing from the recording since individual distillate fractions had been run. Accordingly, if we add in the peak, or peaks, missing for naphtha, we should have at least seven major components instead of the six which the manufacturer thought he had used. This is undoubtedly due to the impurity of commercial materials. For example, we find "pure" amyl acetate to consist of seven major constituents, and butyl acetate to consist of 2 major constituents, one of which shows a peak at position "D". Additionally, you will notice the presence of four other components in smaller amounts.)

INTERNATIONAL LABOUR ORGANIZATION

Chemical Industries Committee

Fifth Session, Geneva, February 1958

Report of the Subcommittee on the Protection of Workers against Occupational Diseases and Poisoning[1]

1. The Subcommittee on the Protection of Workers against Occupational Diseases and Poisoning was set up by the Chemical Industries Committee at its Third Plenary Sitting on 11 February 1958. It was composed of 15 Government members, 15 Employers' members and 15 Workers' members.

2. The Subcommittee elected its Officers as follows:

Chairman: Dr. KAY (Government member, Canada)

Vice-Chairmen: Mr. CRASS (Employers' member, United States)

Mr. PLUMIER (Workers' member, Belgium)

Reporter: Dr. DIDONNA (Government member, Italy)

3. The Representative of the Secretary-General was Mr. ROBERT, who was assisted by Mr. LAREAU and Dr. MURRAY.

4. The Subcommittee held eight sittings.

Terms of Reference

5. The Subcommittee was asked to consider the third question on the agenda of the Fifth Session of the Chemical Industries Committee, the protection of workers against occupational diseases and poisoning; it had before it Report III prepared by the Office. The Representative of the Secretary-General outlined the criteria on which the report was based, and the Subcommittee decided to accept it as a basis for discussion.

General Discussion

6. The first two sittings of the Subcommittee were devoted to a general discussion on the extent of the problems associated with the protection of workers against occupational diseases and poisoning. The Employers' members expressed the view that the high technical standard of the report, coupled with the attendance at the meeting of highly qualified experts in the various aspects of the subject to be dealt with, should furnish the Subcommittee with an excellent occasion to discuss methods of protection against occupational diseases and poisoning. Descriptions of occupational health programmes in chemical enterprises were given and the application of modern industrial hygiene techniques was outlined. In a memorandum (document ODP/D.1) submitted at an early stage of the meeting, the Employers' members considered that the available statistics on occupational diseases showed the chemical industry in as favourable a light as other industries, but that, nevertheless, the potential risks to health were such as to warrant constant vigilance on the part of management, continuous research into the hazards of new substances and processes, and systematic training of workers in safe practices. Although the primary responsibility for the protection of workers continued to rest with the employer, the greatest possible collaboration should exist among all persons concerned with the protection of the health of workers.

7. The Workers' members felt that whatever value could be attached to statistics of occupational diseases, the fact was that occupational diseases were still occurring in the chemical industry. They felt that too much emphasis was being placed on statistics and conventional medical programmes, and too little on preventive measures of technical nature. Plant design, for instance, was one of the main areas in which considerable progress in protection techniques could be

[1] This report was adapted by the Committee at its Ninth Plenary Sitting, on 21 February, 1958, by 110 votes to nil, with no abstentions.

Editor's Note: Dr. Kingsley Kay of this Division represented the Canadian Government at a meeting of the Chemical Industries Committee of the International Labour Office in Geneva last February and acted as Chairman of the Sub-Committee on Protection of Workers against Occupational Diseases and Poisoning. The report of the Sub-Committee is published in the belief that it may be of interest to those in the occupational health field.

achieved. Thought had also to be given to the many users of dangerous substances who had no experience in handling them. There was need for more widespread information on the potential hazards of substances so that workers in all trades, including transport, could be made more fully aware of risks to health. It was also felt that small enterprises were in a much less favourable position than larger ones as regards the means at their disposal for the application of all types of protective measures. The Subcommittee should find some way of dealing with this problem.

8. Another point which arose in the general discussion concerned the definition of occupational diseases. Several Workers' members asked whether a definition of occupational diseases would not be desirable. In some countries lists were prepared of notifiable or compensable occupational diseases, but even where they were being kept up to date, such lists were often incomplete. Many diseases contracted as a result of work were not officially recognized as occupational in origin and therefore not compensable. This created great hardships for the workers. The Employers' members outlined the medico-legal problems involved in the definition of occupational diseases. The difficulty of distinguishing between occupational diseases and other diseases was emphasized. In deciding on legal claims, some flexibility was highly desirable in order that compensation boards could make allowances for particular circumstances. Claims might be more satisfactorily settled if more extensive consideration could be given as to whether the diseases arose out of or in the course of employment. A suggested approach to the solution of the problem of definition was to define not the disease itself but the circumstances in which it might occur. The Subcommittee agreed that the subject fell somewhat outside the scope of its work and therefore it was not pursued.

9. In order to make a systematic examination of the various aspects of the protection of workers against occupational diseases and poisoning, the Subcommittee adopted an agenda (document ODP/D.2) based on the points for discussion outlined in the I.L.O. report. A draft memorandum (document ODP/D.1) was submitted by the Employers' members, and two draft resolutions (documents ODP/D.3 and ODP/D.5) were submitted by the Workers' members, but as the main points in these documents were included in the above-mentioned agenda (document ODP/D.2), it was agreed that this agenda should be used as the basis for the Subcommittee's discussion. The following items of the agenda were discussed.

Plant Design

10. The importance of plant design was stressed at the outset, and instances were mentioned where, because of the incidence of occupational disease, entire plants had had to be demolished and reconstructed with built-in provisions for safety and health. The principles governing plant design were based on a knowledge of the chemistry of the process, the physical state of the substances used, their toxicity, the possible routes of absorption into the body, waste disposal and air pollution abatement. Consultation should therefore take place at the earliest possible stage between the chemist, the engineering staff and occupational health specialists. The toxic properties of new substances should, for maximum protection, be thoroughly investigated before the design is decided upon. Process planning is a complex operation, involving considerations of the effect of the chemicals on the equipment as well as the efficiency of production and the health and safety of the worker. Since equipment ages as well as people, regular maintenance and possibly replacement was necessary, provision for which should be incor-

porated in the basic design. The health of workers should be a primary consideration in plant design. In order to avoid possible risk to the safety and health of workers, plant designed for a certain output should not be permitted to produce beyond capacity. Experience has shown that it is less costly in the long run to introduce protection at the design stage than to attempt to control the hazard by *ad hoc* measures after operations have started.

11. Some discussion took place on the advisability of including in legislation a provision requiring prior approval by the competent authority of plans for premises and equipment. It emerged that the practice varied widely from one country to another and from one state or province to another in a given country. In some cases, consultation had given good results, while in others, prior approval was necessary even when changes in process were contemplated.

12. The growing complexity of chemical plants and processes made the problem of prior examination of plans extremely difficult in cases where inspectorates lacked adequately trained technical staff for the purpose. However, whatever the procedure adopted, voluntary or compulsory, it was agreed that this approach was of the greatest importance in the task of setting up measures to protect the health of workers in the chemical industry.

Knowledge

13. Knowledge of the risks to health was an essential element in the establishment of adequate protective measures. The Subcommittee stressed the importance of including safety and health measures in the basic training of chemists, engineers and technicians. It was recognized that in certain countries curricula for the training of such professional and technical personnel were inadequate or non-existent. The development of such curricula was urgently needed.

14. It would be most desirable to encourage the training of specialists in industrial hygiene as a profession. These were non-medical occupational health specialists known in certain countries as industrial hygienists. The Subcommittee agreed that such persons should hold a university degree in a basic science (chemical, biological or physical, excluding medicine), and have post-graduate training and experience in occupational health. It was recognized that in certain countries physicians with special training in occupational health carry out the functions of the industrial hygienist.

15. There was also considerable need for developing the teaching of occupational health subjects in medical schools. In this connection, reference was made to the conclusions of the Third Session of the Joint I.L.O./W.H.O. Committee on Occupational Health.

16. At the plant level, means should be taken to ensure that all personnel, including management, medical and allied personnel, supervisors and foremen, are kept fully aware of potential risks to health. Workers should be thoroughly instructed in methods of protection against such risks. Data sheets and other publications of a similar nature would be most useful in this connection.

17. In discussing the methods by which workers could be instructed in health hazards and protective measures, the Subcommittee emphasized the importance of establishing training programmes for new workers and of continuing this training during the workers' employment. Regular instruction should be furnished on these subjects by competent medical or technical persons. Instructions to all workers on the immediate action to be taken in case of accident and training of an adequate number of persons in first aid and the proper use of first-aid and rescue equipment should be given. With regard to dangerous substances, in particular, the Subcommittee recommended that warning labels, based on the relevant I.L.O. recommendations or on practices of the country concerned, should be affixed to containers of dangerous substances.

Research and Investigation

18. The Subcommittee considered that it was necessary to stimulate and develop to an increasing extent scientific research into all aspects of occupational health. Such research, conforming with the suggestions of the Third Session of the Joint I.L.O./W.H.O. Committee on Occupational Health, might be carried out either in laboratories attached to industrial establishments or in occupational health institutes established under government or other sponsorship. Research projects might include basic research, including the pre-testing of new chemicals; and applied research, including the selection of possible safer substitutes and other specific problems submitted by small or large industries, health authorities, labour inspection departments, trade unions, social security organizations and other agencies, the objective being to provide service in the field of occupational health. The fullest co-operation should exist between industry, government agencies and the research institutes.

19. The Subcommittee strongly supported thorough investigation of individual cases of occupational diseases and poisoning, recognizing that this may require study from the medical, engineering and chemical aspects. Collaboration was considered desirable between government inspectorates and industry, in particular the medical, industrial hygiene and safety specialists, as well as joint safety, welfare or other appropriate committees. The Subcommittee recommended the establishment of laboratory facilities staffed by industrial hygiene and safety personnel to the extent necessary in making such investigations.

Application of Knowledge

20. In considering the technical measures which might be adopted to control risks to health, the Subcommittee stressed the substitution of harmless or less harmful substances for harmful substances wherever practicable. This was considered to be a fundamental principle of protection. Among other technical measures of reducing the exposure to risk, attention was drawn to the value of automatic or remote handling of certain dangerous substances; efficient ventilation for the removal of toxic dusts, fumes, gases and vapours; wet methods for dust suppression; identification and isolation of dangerous processes and equipment; and general cleanliness and good housekeeping in the plant. The application of safe working methods, such as the control of the entry of persons into tanks, flues, pits, pipes and similar confined spaces was also important. New chemical substances should not be furnished to consumers until any dangerous or toxic properties of such substances are sufficiently known.

21. In certain cases protective equipment should be supplied to the individual worker particularly where the risk cannot be controlled effectively by the above technical measures; it is essential to provide suitable protective clothing (gloves, boots, helmets, overalls, etc.), efficient respirators, effective eye protection and adequate washing facilities. It was suggested that protective equipment should, as far as possible, be issued for individual use, and that, where the same equipment may be used by two or more persons, it should be thoroughly cleaned before reissue. The question of barrier creams was discussed and the Subcommittee was in agreement with the opinions expressed on this subject in the Office report. Briefly, these were that reliance cannot be placed on barrier creams alone and that they were no substitute for good washing facilities, although, when used as additional to these measures as specific for the type of chemical involved, they may be valuable.

22. The Subcommittee underlined the importance of occupational health services and took note of the definition of occupational health arrived at by the Joint I.L.O./W.H.O. Committee on Occupational Health at its First Session. The value of initial and periodic medical examinations of workers exposed to certain health risks was emphasized, the aim of such examinations being to adapt the work to man and each man to his job.

National and International Co-operation

23. With regard to national and international co-operation on questions relating to the protection of the health of workers in the chemical industry, the Subcommittee considered that the I.L.O. should continue to provide information on the toxic hazards of chemicals, and particularly of new substances, by the publication of articles and abstracts in *Occupational Safety and Health*, the preparation of data sheets on dangerous substances, and the revision of the Encyclopaedia, "Occupation and Health". Particular stress was laid on the importance of the publication of data sheets at an early date.

24. The I.L.O., in collaboration with the W.H.O. and other international organizations where appropriate, should encourage international co-operation by promoting the establishment of institutes of occupational health in countries which are in the course of industrialization, by technical assistance, and by the collection and evaluation of statistics of the incidence of occupational diseases and poisoning. These statistics should be established in accordance with methods as uniform as possible.

Adoption of Report and Conclusions

25. In concluding its work the Subcommittee unanimously adopted a resolution (the text of which is appended) concerning the protection of workers against occupational diseases and poisoning. This was preceded by a discussion during which an amendment concerning the insertion of a further paragraph in the preamble of the resolution based on the considerations set forth in paragraph 6, above, was proposed by the Employers' members. The amendment was rejected on a vote, there being 15 votes in favour, 24 against and 6 abstentions.

26. This report was unanimously adopted by the Subcommittee at its Eighth Sitting on 20 February 1958.

APPENDIX

*Resolution (No. 33) concerning the Prevention of Occupational Diseases and Poisoning in the Chemical Industries**

The Chemical Industries Committee of the International Labour Organization,

Having been convened by the Governing Body of the International Labour Office, and

Having met at Geneva in its Fifth Session from 10 to 21 February 1958,

Having discussed the Report prepared by the Office concerning the Protection of Workers against Occupational Diseases and Poisoning,

Adopts this 21st day of February 1958 the following resolution:

Design of Premises, Plant and Equipment

1. The health of workers should be a primary consideration in the design of premises, plant and equipment for the chemical industries. Consultation should therefore take place at the earliest possible stage between the chemist, the engineering staff and occupational health specialists, so as to ensure that the design, in its final form, will be devoid of any elements which might adversely affect health.

2. The toxic properties of any new substance which it is proposed to use or to produce in the chemical industry should be thoroughly investigated before the details of the process concerned are finalised. Where necessary, the design of the plant should be adapted in the light of the results of such investigations, so as to ensure maximum protection of workers.

3. The design of plant and equipment for use in the chemical industry should incorporate suitable provision for regular maintenance and, where necessary, replacement.

Basic Training

4. The basic training of chemists, engineers and technicians should include instruction in safety and health measures.

5. Encouragement should be given to the training of technicians in industrial hygiene as a profession.

6. Steps should be taken to ensure that medical practitioners are fully informed of the importance of occupational health. Such steps might include the giving of relevant training to medical students and the training of specialists in this field.

Plant-Level Training

7. Management, medical and allied personnel, supervisors and foremen, should be kept fully informed of any risks involved in the undertaking with which they are concerned, and of the latest developments with regard to protection against such risks.

8. The training of chemical workers should include instruction in the hazards to which they may be exposed, and special emphasis should be laid on the necessity of such protective measures as may be required. Such training can be ensured by:

(a) instruction during the course of preliminary training;
(b) regular training programmes;
(c) pamphlets, posters, lectures and data-sheets;
(d) regular instruction by competent medical or technical persons; and
(e) warning labels affixed to containers of dangerous substances, such warning labels to be based on the recommendations of the I.L.O. or on the practices of the countries concerned.

9. Instruction should be given concerning the immediate action to be taken in case of accidents on the job, and an adequate number of persons should be trained in first aid and in the use of first-aid and rescue equipment.

Research and Investigation

10. Scientific research into all aspects of occupational health should be stimulated and developed to an increasing extent in specialized laboratories attached to establishments, or in public or private occupational health institutes. Research should be undertaken with a view to the employment, whereever practicable, of harmless or less harmful substances for dangerous substances.

11. The fullest possible co-operation should exist between industry, government agencies and research institutes with a view to providing industry with adequate service in the field of basic and applied research.

12. Individual cases of occupational diseases or poisoning should be thoroughly investigated in all their aspects—medical, engineering and chemical—in collaboration with the government inspectorate concerned, management and joint safety, welfare or other pertinent committees.

Technical Measures for Protection

13. Steps which should be taken to eliminate health risks include the following, as may be appropriate:

(a) modification of processes;
(b) suitable ventilation; general exhaust;
(c) automatic or remote-controlled handling of certain dangerous substances (e.g. radioactive substances);
(d) enclosed processes;
(e) marking and isolation of particularly hazardous processes and apparatus;
(f) wet methods to reduce dust; and
(g) good housekeeping.

14. Working methods should be such as will reduce exposure to risk. Such working methods should include, *inter alia*, the control of entry into tanks, flues, pits and pipes, and similar confined spaces.

15. Adequate measures should be taken for personal protection. Such measures may include the provision and use of suitable protective clothing, efficient respirators, eye protectors, barrier creams and adequate washing facilities.

16. First-aid and rescue equipment, appropriate to the special risks of each case, should be readily available and should be regularly tested.

Medical Measures

17. Recognition should be given to the importance of occupational health services, as defined by the Joint I.L.O./W.H.O. Committee on Occupational Health at its First Session.

18. Workers exposed to certain risks should be subject to initial and periodic medical examinations of fitness for the work in view.

Substitution

19. Attention is drawn to the resolution adopted by the International Labour Conference at its 35th Session (June 1952) on the desirability of applying the principle of substitution of harmless or less harmful substances for harmful substances. It is recognized that the knowledge acquired through scientific research and its industrial application is such as to make substitution possible in certain cases, and that substitution, where it is practicable, is one of the best methods of protecting workers against occupational diseases and poisoning.

Action at the International Level

20. The Governing Body of the International Labour Office is invited to instruct the Office:

(a) to investigate, with the help of experts, and to report on the substances and processes to which it would be economically and technically practicable to apply the principle of substitution; and to indicate the nature of possible action that could be taken in this connection;
(b) to compile, with the assistance of experts, data on the best current practice with regard to technical measures for the control of risks to the health of workers handling hazardous substances;
(c) to continue to collect information on the potential hazards of dangerous substances and their control, with a view to its dissemination in appropriate forms, such as data sheets, the revised Encyclopaedia of Occupational Health and Safety and the periodical "Occupational Safety and Health"; and
(d) to keep the I.L.O. list of dangerous substances up to date and to continue preparing basic information to appear on warning labels for containers of dangerous substances.

*This Resolution was adopted by the Committee at its Ninth Plenary Sitting by 115 votes to nil, with no abstentions.

OTTAWA
Edmond Cloutier, C.M.G., O.A., D.S.P.
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1958

OCCUPATIONAL HEALTH *Review*

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A QUARTERLY PUBLICATION